Vegetation Control on Railway Tracks and Grounds

SBB CFF FFS

Swiss Agency for the Environment, Forests and Landscape (SAEFL)

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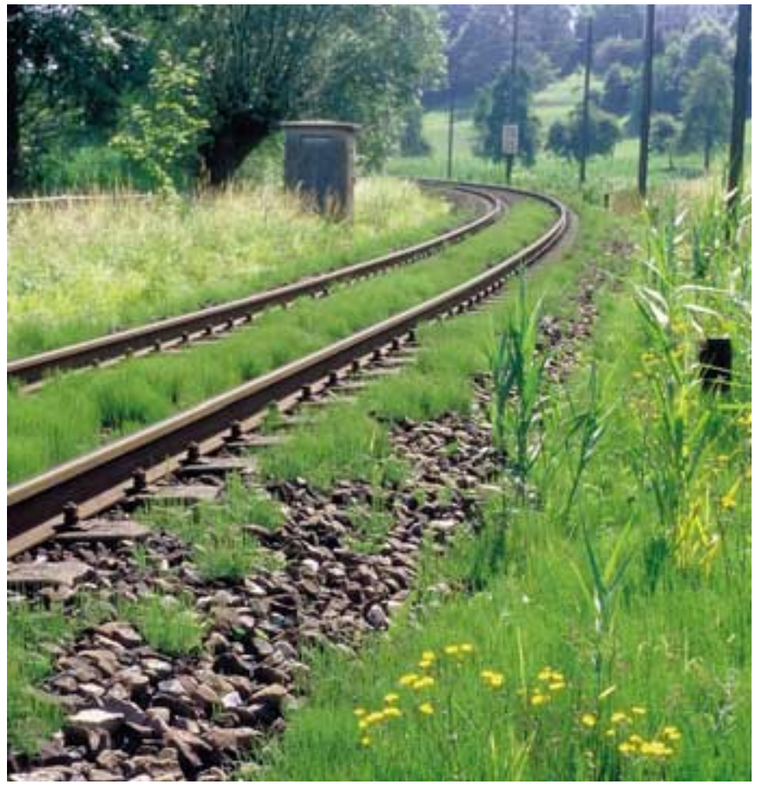


Overgrowing vegetation in the track area can be a danger to railway operation. Weeds must be controlled with measures appropriate to the location, and to the type and extent of line use.

Just how free of weeds the track area must be will depend above all on the operational requirements the line must meet. The control measures described in this brochure are designed to guarantee productive efficiency and operating safety of the railway in the long term, whilst ensuring the best possible protection for the environment.

Strategy, Solutions and Limitations

Modern train operation makes very high demands on railway tracks. These demands can only be met if the ballast bed is as much as possible free of vegetation. In earlier years, soil herbicides were used to achieve this goal. However, the chemicals used (such as Atrazine) had a low degradability. This and the high permeability of the track sub-structure led to pollution of ground- and drinking water. A working party comprising representatives from SBB, private railways, agricultural research centres, the Federal Transport Office (BAV), the Swiss Federal Office for Public Health (SFOPH) and the Swiss Agency for the Environment, Forests and Landscape (SAEFL) was set up to take a new look at vegetation control on railway tracks and grounds.

The working party, chaired by SBB, investigated other methods of vegetation control in an effort to find alternatives to chemicals. Particular attention was given to constructional, biological, mechanical and thermal measures.

The main concern today is to bring vegetation under control through the use of a combination of different measures appropriate to the specific situation. More specifically, this means that preventive measures should already be addressed in the planning and projecting phase, and that the periodical maintenance of the lines must be guaranteed. To complement this, existing vegetation is removed using measures that combat the symptoms.

This brochure is designed as a basic guide for anyone involved in vegetation control on railway tracks and grounds. Its purpose is to make people aware of the possible options and problems whilst also describing the current methods and how they can be combined.

Target Group

To optimise vegetation control from an economical and ecological point of view, it is essential for all the technical departments of a railway company to be aware of the problems associated with railway vegetation and to have some basic knowledge of the subject. If, for example, the question of vegetation control is already taken into account during the planning and projecting phase of a new line construction or renewal scheme, this will help to reduce the time and money spent later by the maintenance services. This brochure is therefore directed to all those responsible for

- **planning**
- **project work**
- **execution**
- **maintenance**
- **renewal**
- **regeneration**

associated with railway installations, or to those involved in the related activities.

Things We Should Know About Plants...

A basic knowledge of plant growth is a prerequisite for effective vegetation control. This can lead to a better understanding of the interactions between the measures taken and plant behaviour. It can also help avoid inappropriate applications that are not effective, or whose effect is even counter-productive. Reference is also made in this connection to the overview of common problem plants on pages 24 and 25.

Basic principles of plant growth

To grow, plants need light, nutrients, and above all, water. The less water there is available to a plant, the less it grows.

To survive periods of little precipitation, plants depend on the water-holding capacity of the soil, which on its part is a function of the soil structure. Humus, fine-grained silt and clay can hold large quantities of water, whilst coarse-grained materials like washed sand, stone chippings, ballast and boulders do not have this ability. They repress plant growth. A thin separating layer of coarse-grained material is usually sufficient to cut off the roots from the water supply.

Humus also contains many nutrients that plants also need in order to grow.

The installation of coarse-grained separating layers without humus, silt and clay has an extremely stunting effect on the settlement and growth of most types of plants.

In principle, three main groups of plant species are of importance in track-bed maintenance. These are described in more detail below.

Plants are excellent indicators of the state of the soil. The rich growth of horsetail in the picture shows that the ground in this area is damp and therefore unstable. Here, the result has been track subsidence.

Seed dispersion species

Most plants propagate and spread through seed dispersion. These types can efficiently be controlled through constructional measures designed to inhibit growth.

Seeds normally germinate at the surface of the soil and their roots then grow down in search of water. If the roots can locate neither water nor nutrients – in other words if the ballast bed and verge are free of dirt able to store water and nutrients – the young plants will simply die.

For this reason, new verges should be built up with a coarse-grained layer (e.g. gravel, ballast), and in the ideal case should be covered with fine-grained materials such as stone chippings, and should be periodically maintained (cf. SBB Regulations 211.1). For older verges, a periodical maintenance is recommended.

A typical seed-dispersion plant is cranesbill.

Species propagating above ground

Problem plants like brambles or traveller's joy propagate by sending out runners above the surface. Where a runner comes into contact with the soil, new roots form, from which runners are again sent out. If however the runners are continually cut back, the plants are unable to propagate further.

Plants that propagate in the track area by sending out runners above ground can be kept under control by regular cutting back and mowing in the bank area (see «Mowing» p. 15).

Bramble is a typical plant that propagates above ground.

Species propagating from below ground

Plants that penetrate the track area underground, such as horsetail or reeds, are the hardest to control. These species start by pushing their roots horizontally out into the damp natural subsoil before forming new shoots at the surface, which then grow into new plants that send out their own suckers. Their roots or shoots can even penetrate heaps of dry gravel, drainage concrete or scree material.

In this way, a whole network of roots develops. This root system can be between 1 and 2 metres below the surface, with extensive, interlinked ramifications spread over a considerable area, helping the plants to obtain water and nutrients, even in dry periods. These species are most common in damp, clay or silty soils.

In the long term, plants propagating from below ground can only be controlled through renewal of the substructure.

Reed – a typical problem plant, propagating from below ground.

Requirements of the Different Track Areas

Before combating plant growth in and around the track area, two basic questions must be answered:

- **Where should or must the track be free of vegetation?**
- **Where is a certain amount of vegetation to be tolerated, given the age, constructional condition, traffic density and time to next renewal of the installations?**

To be able to answer these questions, it is necessary to know the importance of the different track areas.

Maintenance zones

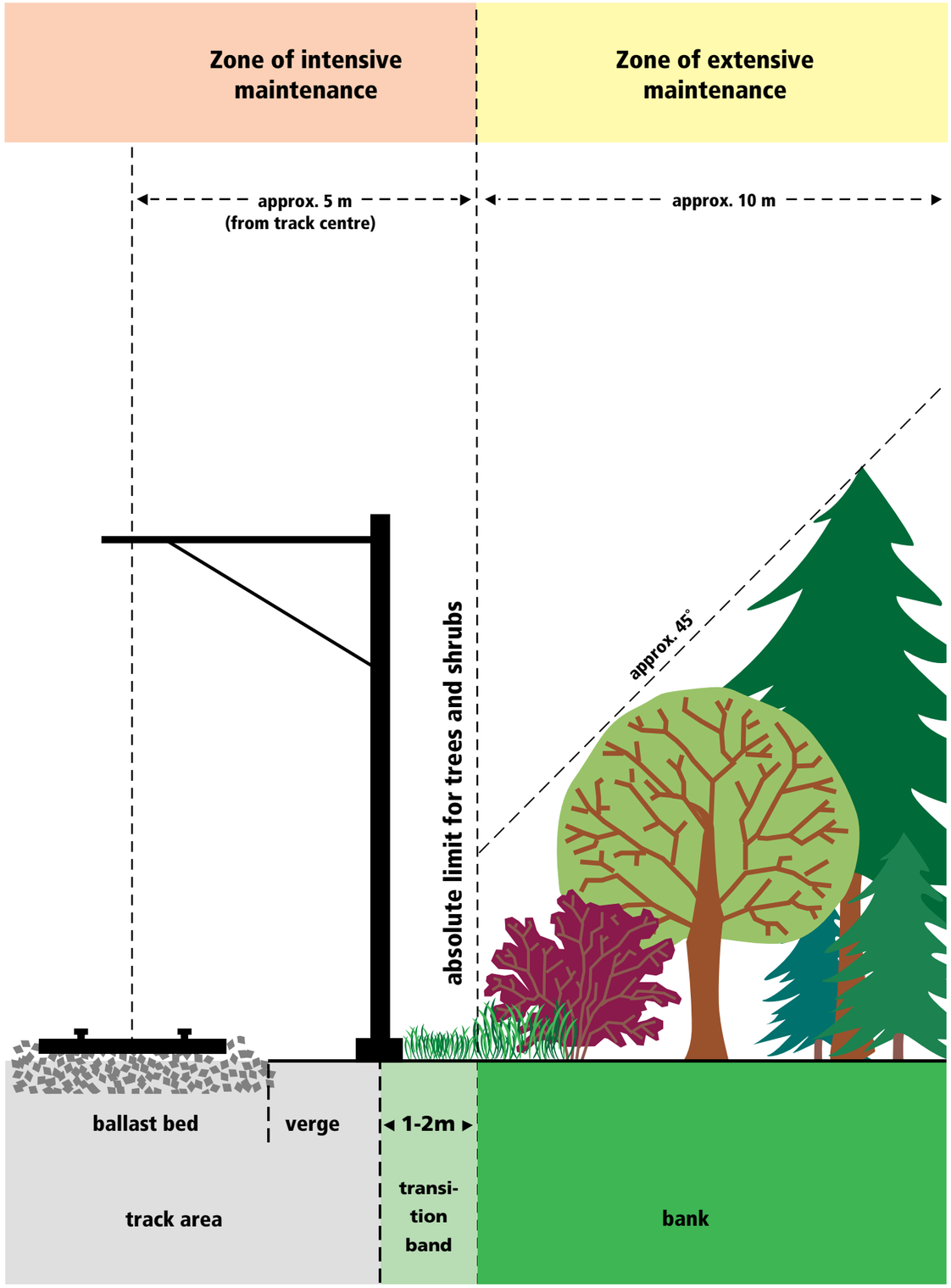
The trackbed construction can be divided into the ballast bed, the verge and the bank. Each of these areas has a different role to play and therefore has specific requirements on vegetation control. This information is set out in detail in the Swiss standard «SN 671 560».

Beside a differentiation according to construction elements, to differentiate between intensive and extensive maintenance zones is also important. Special attention must be given to the 1 to 2 m wide transition band between verge and bank, situated in the zone of intensive maintenance.

Within the zone of intensive maintenance, safety is the paramount consideration. While no growth is permitted in the actual track area (the ballast bed), regular mowing of the area between the verge and the bank should ensure that a thick band of grass forms there to prevent weeds from propagating into the track area.

Within the zone of extensive maintenance, ecological and economical aspects have to be considered, besides those of safety. This can be achieved by regular maintenance. In particular, the use of herbicides is forbidden here.

	Zone of intensive maintenance		Zone of extensive maintenance
	Track area	Transistion band	Bank
Maintenance goals	✓ ballast bed stability ✓ durability of materials and verge ✓ unhindered access ✓ unobstructed view	✓ vegetation barrier	✓ stability of bank and vegetation ✓ protection from projecting or falling wood ✓ protection from the forces of nature ✓ unobstructed view ✓ vegetation barrier
Vegetation	✓ none	✓ thick grass ✓ no shrubs or trees	✓ various vegetation types
Measures	prevention and removal of vegetation: ✓ constructional measures ✓ chemical measures ✓ thermal measures ✓ mechanical measures	promotion and care of non propagating plants: ✓ biological measures	✓ Keeping the clearance gauge free ✓ Maintenace based on ecological principles including aesthetic considerations
Factors to consider	✓ Prevention of water pollution ✓ Cost-effectiveness		✓ Preservation of nature and the landscape ✓ Cost-effectiveness



Weighing of Interests

When maintaining railway installations or carrying out vegetation control, a number of different aspects must be considered. Apart from pursuing the goals of a long-term safety guarantee, also functional efficiency and cost-effectiveness of railway installations, the protection of the environment, the preservation of the countryside, and the prevention of water pollution, have at any rate to be taken into consideration. The essential obligations to be observed are set down in the environment protection law, the law on the protection of regional values and traditions, the landscape preservation law, as well as the water protection law.

Basically, more vegetation can be tolerated on sidings or lightly used connecting lines. Neglecting maintenance on lightly used secondary lines will however lead to a rapid deterioration in their condition, with the result that speed restrictions have to be imposed. The lines may even have to be closed.

The distinction between zones of intensive and extensive maintenance gives a clear indication of where the vegetation must be controlled on railway tracks and grounds and with what kind of measures. These requirements can be applied by analogy to those areas that are visible to the eye – the ballast bed, verge and bank. Depending on the characteristics of the landscape and the age of a line, the individual areas can vary considerably in size and condition. The width of the transition band between intensive and extensive maintenance zones (i.e. between the verge and the bank) is particularly variable, but should be around 2 metres wherever possible.

Ballast bed

With the high speeds and loads of modern rail traffic, operating safety dictates that the ballast bed be virtually clear of plant growth.

- A dirty or overgrown ballast bed loses the resiliency that is essential for high operating speeds.
- Plant roots and dirt store water that can freeze and expand in winter. This leads to a change in track geometry which in the worst case can lead to derailments.
- Plants that grow over the rails can reduce adhesion essential to power transmission and braking.

The extent to which ballast must be free of vegetation depends above all on the number of trains and their speeds.

Verges

The verge can fulfill several functions in vegetation control depending on the situation. It can serve:

- as an element in the drainage of the track;
- as a barrier to stop plant incursion reaching the ballast bed;
- as a walkway for inspections and maintenance work.

Good quality verges are also important for work to be performed in the ballast area.

When used as a walkway, it is sufficient to keep the verge free of plants like brambles, traveller's joy and shrubbery that might make people stumble over them. More vegetation can be tolerated on open lines than in marshalling yards and stations where walkways are used every day.

Verges built according to accepted standards, and in combination with a grass-covered and regularly mown transition band can be an ideal vegetation barrier against weed incursions.

Transition band

Regular mowing of the transition band promotes a dense grassy vegetation. This is a good barrier against problem plants growing into the track area from the bank.

Banks

Professional maintenance of the railway banks protects the track area against lateral plant incursions.

For reasons of operating safety and vegetation control, no trees or shrubs are allowed to grow in the vicinity of the track (about 5 metres from the track centre). Potential hazards include falling trees, lack of visibility, excess shadow, falling leaves and the added humus that such growth would bring.

In Switzerland this protection is ensured through regular attention to the banks in accordance with Swiss standard «SN 671 560».

Regular mowing of the bank keeps trees and shrubs at bay and prevents weeds from propagating into the track area.

Environmentally Favourable Vegetation Control

The methods of vegetation control currently used by SBB can be divided into two main groups: procedures for removing or repressing existing vegetation, and measures directed to the causes of plant growth. In practice, it is usually an optimal combination of a variety of measures that is the most effective.

In principle, constructional and biological measures are the most effective when a line is built or renewed (bituminous weed barriers, porous concrete barriers, lateral barriers and green bands with selected vegetation). These measures prevent plant growth by reducing the amount of water in the substructure and serving as a barrier against plant incursion.

In the longer term however, these effects will decrease, which is why it is so important to maintain the lines (mowing of the bank in the track vicinity, cleaning out of drains). Even though vegetation control is not the primary objective of some maintenance works such as ballast cleaning, these often have a salutary and wished-for side effect.

Where vegetation persists in the track area in spite of constructional measures and regular maintenance, plants can be removed mechanically, chemically or thermally, depending on what is permitted.

Sustainable, environmentally favourable vegetation control on railway tracks and grounds is possible if the following priorities are observed:

- **prevention of plant growth through appropriate constructional and biological measures;**
- **preservation of the growth-inhibiting state through regular maintenance;**
- **removal of vegetation by mechanical, chemical and thermal means as and when necessary.**

The methods of vegetation control used by SBB today. In practice only an optimum combination of measures will generally deliver a sustainable and cost-effective result.

Prevention of undesired vegetation (combating the causes)

Removal and repression of undesired vegetation (combating the symptoms)

constructionally	biologically	mechanically	chemically	thermally
see page 12	see page 14	see page 16	see page 18	see page 20

Combination of methods tailored to the situation in hand

Environmentally favourable vegetation control

Prevention of Undesired Vegetation

Plant incursion into the track area can best be prevented or discouraged by ensuring that conditions of growth in the verge are as unfavourable as possible (reducing the amount of water, nutrients and light). However, the success of a given method will depend on the type of vegetation and the site in question. To combat some so-called problem plants (see p. 24 and p. 25), other methods than those used for normal weeds are required.

The absence of shade trees tends to discourage plant growth in the track area.

'Problem plants' present

The best way to deprive problem plants (e.g. those that propagate from underground) of water they need for survival, is to build deep-set drainage systems, and at the same time to replace the whole layer of soil interspersed with roots. But mostly, this procedure is possible only in connection with a renovation of the substructure, and it is the most cost-effective if the verge is to be renovated for operational reasons.

A cheaper method is to insert foils into the verge. These foils should be resistant to root growth, degradation and weather influences (see page 13). A precondition for this is that water run-off is provided and that sufficiently strong competition vegetation is stimulated in the adjoining transition band. This helps to limit lateral incursions by problem plants (compare «Mowing», p. 15).

'Problem plants' absent

Seed plants, and plants propagating above ground can best be combated by plant- inhibiting construction measures (substructure materials without clay, silt or humus). A sufficiently thick (conforming to SBB Regulation R 211.1) and clean ballast bed will be especially effective in durably depriving seed plants of their necessary basis of existence. After rainfall or other forms of precipitation, it is important for the ballast to dry out as fast as possible – the track should therefore not be overshadowed by trees. The lateral drainage of the substructure and the ballast bed also has to be guaranteed.

Plants usually start to grow at the base of the ballast shoulder, where the ballast layer is the thinnest. Ensuring that a sufficiently thick layer of ballast reaches as far as the verge can therefore also help prevent plant growth.

Well placed and solid cable trenches, concrete border elements, covered porous concrete barriers and solidly-built verges are suitable as lateral barriers against plant incursion into the track area.

As experience shows, a substructure made of sand and gravel without a bituminous layer does not meet the requirements of a plant-inhibiting construction design. The sand and gravel mix alone cannot ensure complete dryness.

Constructional Measures

Constructional measures designed to reduce the amount of available water in the track area have proven to have the best preventive effect against weeds. However, because of the high costs involved in the construction work and the disruption of operations, measures of this type are not cost-effective if their sole purpose is vegetation control. It is therefore necessary always to take due account of vegetation control aspects when engineering works are planned for operational reasons. The basic requirements for constructional measures are set out in SBB Regulation R 211.1.

Bituminous weed barriers

A sufficiently robust and compact layer of bitumen beneath the ballast is a solid barrier against rising soil moisture and also prevents pollution and softening of the substructure due to precipitation soaking into the ground.

Bituminous weed barriers that conform to Swiss standard «SN 640 431b» stop the propagation of problem plants from below almost entirely.

Cost: 20 - 80 sfr./metre

Bituminous weed barriers today are standard procedure for SBB, among other constructional measures.

Properly built and maintained verges can repress undesired vegetation for up to 30 years.

Verge design

Verges with a compacted, wear-resistant top layer of a finer material will inhibit most forms of plant growth. A smooth verge surface that slopes towards the outside has the additional advantage that almost no organic matter can settle on it. With time, though, some unpretentious plants will grow here. To keep the verge free of vegetation for a longer time, extremely growth-inhibiting materials can be used for the verge (gravel made of calcium-free silicate). Bear in mind that this measure on its own will not deter plants that propagate from beneath the surface.

If the verge and transition band are given regular care, verges built in this way in areas that are largely free of problem plants (e.g. reed and horsetail) should last for anything up to 30 years (except for very steep banks without shoulders and narrow cuttings).

Providing the underlying drainage layer and barrier have a proper effect, a replacement of the overgrown, humus-rich layer of gravel on existing verges, provides for a new growth-inhibiting effect for several years against wild seed plants. The new surface material, selected for its grain size properties, will nonetheless need to be compacted.

Verges built on new lines are now composed of ballast because of its better permeability. Since in this case vegetation can only be removed at substantial cost, the verge must be kept free of plant growth by regular and professional maintenance (see «Biological Measures», p. 14).

Cost: 20 - 30 sfr./metre

Lateral barriers

Verges that are built with a plant inhibiting construction, already constitute effective barriers against plant incursion. With the addition of cable trenches, bars and step blocks as lateral barriers, the overall effect is even enhanced. Where verges are lacking or need to be raised, concrete slabs in upright position are also suitable. However, a proper drainage of the track structure must always be ensured.

Cost: 300 - 800 sfr./metre

Solid cable trenches form good barriers to the incursion of plants.

Porous concrete barriers

The porous concrete barriers that SBB has built in the verges of existing lines since the late 1980s are a good barrier against plant incursion. They can be built quickly and easily and at reasonable cost, and are therefore particularly suited when existing lines are reconstructed. Concrete barriers for drainage must however not impede the mowing of the adjacent band of grass.

Requirements governing the installation of porous concrete barriers are set out in Annex 9 to SBB Regulation R 211.1. Covering the concrete barriers with a layer of finer material can help to efficiently filter out humus and nutrients.

Cost: 150 - 300 sfr./metre

This gap in a porous concrete barrier illustrates the effectiveness of this technique.

Insertion of foils

Integrating foils in the construction of the verge is a simple way of preventing plant incursion. These foils must however be undegradable, resistant to atmospheric corrosion, and must resist root growth of horsetail and reeds (e.g. fleece is not suitable, as plants can grow through it). If, however, problem plants are already present, then also the foils will not be able to stop them.
When the foils are built in, attention should be paid to ensuring that water run-off from the sides of the ballast bed is guaranteed and that the foil reaches around 50 cm under the ballast. It must slope sufficiently outwards, which means that the verge surface must previously be renovated. The foil must also be secured against the wind using gravel or a similar material.
The costs indicated below result from a trial scheme and are therefore rather high. Were the foils to be laid concurrently with rebuilding work, substantial savings would result.

Cost: 100 to 150 sfr./metre

Where the foil ends, the vegetation spreads.

Biological Measures

Biological measures are used to shape and treat the transition band and the bank so that only such plants can grow on them as do not interfere with railway operation and maintenance.
While constructional measures mostly mean a change of the soil structure, shaping work means the sowing or planting of non-interfering species, appropriate maintenance, selective weeding of the bank, removal of shrubs and trees and regular mowing or grazing. All of these works require adequately trained specialists.

Influencing the composition of the plant species requires knowledge in the fields of:

- soil quality;
- habitat requirements and the ability of single plant species to compete with others;
- plant reactions to specific treatment methods.

For example, the different competitive abilities of plants can skilfully be used to good effect. Since regular mowing is harmful to those plants that send out runners, these species will be superseded by others less or not at all affected by such a measure. To ensure that this ousting mechanism functions properly, the local conditions (particularly the soil composition) must be such as to encourage the growth of the favoured plant species.

Wet, clayish and compacted soils, which favour the growth of problem plants penetrating underground into the ballast bed like horsetail and reeds, should either be replaced to a sufficient depth near the track, or drained, or improved. Only in this way, problem plants can be superseded. A welcome advantage here is the fact that at specific places, the replacement of unsuitable, loamy soil has always been a tried method of the railways to improve track stability.

Knowledge of the biological interactions between the soil, the competitive strategies of plants and their reaction to specific types of treatment is also useful for new line constructions, where, depending on the situation, measures to prevent erosion are necessary.

Apart from constructional measures that are unavoidable in problem areas in the long term, biological maintenance remains a standard activity for railway companies. To perform it optimally, it is wise to work with an official green area cadaster.

With the exception of mowing, the costs of biological measures cannot be stated with any accuracy because of the big differences between the local conditions.

Greening

The deliberate sowing of desired plants will generally follow after completion of the engineering work and focus on the transition band in the track vicinity. SBB experience shows that the transition band should ideally be sown with seeds adapted to local conditions as soon as possible after completion of the engineering work (preferably in the spring). Leaving these areas for spontaneous plant coverage will often result in a large proportion of problem species. This can happen especially where new earth containing seeds and particles of plants able to germinate is spread in the area bordering on the bank. On the other hand, spontaneous natural plant coverage should generally be encouraged in the zone of extensive maintenance. Banks that are liable to erosion and subsidence should however be planted quickly (see SBB handbook «Grünflächen bei Bahnanlagen, Projektierung», chapter D «Begrünung»).

Cost: approx. 5 sfr./square metre

Loose vegetation and not sufficiently frequent mowing promotes the growth of unwanted plant species in the transition band (e.g. thistles).

Mowing

Without regular attention, vegetation will develop into woodland in most cases. It is therefore important to mow the grass in the zone of extensive maintenance at least once a year. Longer intervals will lead to the growth of wooden plants and a higher proportion of wood in the plant material that the mower encounters. The latter results in a higher consumption of energy, and a lower performance per surface unit. Problem plants like Japanese knotgrass, brambles and reeds tend to spread far more quickly if mowing intervals are longer.

Mowing is effective for up to a year against growth of brambles, traveller's joy, bushes or trees on a soil favourable to meadow plants. Regarding horsetail and reeds, this effectiveness lasts roughly half as long. For this reason, during the growth period at least one to two mowing operations a year will be needed on the transition band.

With a greened verge (see page 28), note that this indication applies only if no herbicides are used in the area being mowed, as herbicides will destroy the plants that compete naturally with horsetail and reeds. Horsetail, which is resistant to Glyphosate, will even benefit from the operation.

In this connection it is mandatory to pay attention to the fact that the use of herbicides with few exceptions is forbidden in the bank area!

Below, an overview is given on the most common mowing methods used by the railways:

Scythe
Purely manual work, noiseless, but with low surface area coverage.

Motor scythe
Best used to mow around obstacles and in areas that are difficult of access or not suited to larger equipment.

Motor mower
Used mostly on smaller or sloping areas and to protect valuable plant stands.

Rotary mower
Mowing device mounted on a tractor. The cuttings are usually left on the ground as mulch. It is important that the cuttings should not be spread onto the ballast or verge. A newly-developed bank mower caters to this requirement by blowing the cuttings out into the bank area.

Self-propelled rotary mower
All-terrain, 4-wheel drive vehicle with a front-mounted mowing device. Possible sideways slippage can damage the bank.

Rotary mower with suction device
This is similar to a standard rotary mower, but fitted with a suction device to collect the cuttings in a mobile container. To prevent further enrichment of the humus content of ballast and verge, use of suction equipment is recommended above all in cuttings and on the mountain side of sloping terrain. Usually, only cuttings from the band of greenery immediately adjacent to the ballast are removed by suction. However, to protect animal life in the bank, this procedure is not recommended in the zone of extensive maintenance.

Cost: 0.2 - 0.7 sfr./square metre

Selective maintenance

Outside the area of intensive maintenance, a low-maintenance vegetation suited to local conditions can be achieved by selective thinning out of trees and shrubs in compliance with Swiss standard «SN 671 560». Preference is given here to slow-growing and small species.

Particularly undesirable plants can be removed by selective weeding by hand, hoeing or cutting. Especially in shady places such as wooded recesses, seedlings of trees or bushes are often to be found, which should be removed in autumn and winter.

The production of a green area map or cadaster can be extremely helpful for planning and implementing special environment-friendly measures such as these.

Cost: 1 - 3 sfr./square metre

The picture clearly shows the different control methods used for areas of intensive and of extensive maintenance.

Mechanical Measures

Plants are removed from the track area by mechanical measures. Therefore these measures belong to those attacking the symptoms. With ballast cleaning and suction devices, not only the plants themselves are removed, but also the dirt which is the basis of their existence. As such there is also a preventive dimension to this kind of work. Although both these procedures are used first and foremost to guarantee track stability, they fulfill also an essential role in vegetation control.

Ballast cleaning

If the ballast bed is to remain free of weeds in the long term, then ballast cleaning is an important measure. A ballast bed that is clean and dry throughout will not permit plant growth, though propagation of problem plants from below ground is still possible.

The ballast cleaning machines used on the SBB network pick up the dirty ballast with a conveyor scoop or an excavator belt. The material thus extracted is passed through a mechanical cleaning system in which the fine particles are sifted out. The cleaned ballast is then spread back beneath the track.

A good ballast cleaning can be effective from 20 up to 40 years, depending on local circumstances and traffic density, if the adjacent verges and banks have been built and planted in compliance with the rules, and are properly maintained.

Cost: 300 - 500 sfr./metre

A ballast bed that is clean from top to bottom, largely prevents plant growth.

Suction method

A suction device mounted onto a road-rail vehicle removes unwanted material (cigarette ends, organic waste, leaves, humus, sand, etc.) from the surface of the ballast bed. This operation thus contributes to the prevention of weeds on railway tracks. Since the vehicles move very slowly and therefore occupy the line for a long time, they are only used in and around stations and on lines with little traffic. For operational safety, it is also very important that compacted ballast does not become loose as a consequence of this kind of treatment.

Cost: 4 - 5 sfr./metre

By removing dirt and rubbish from the ballast, a preventive contribution is made to vegetation control.

Mechanical weeding

There exist a few machines that can weed and clean the verge, but none of them has been heavily tested as yet. By mechanical peeling of plants from the surface during dry summer weather, it is possible to defer the constructional renewal of the verge by several years. It is however important that the material removed, which is rich in humus, is not left lying on the inspection walkway or the ballast bed. This procedure can only be used on gravel verges and surfaces. Daily performance is 1 to 2 km.

Cost: with machine operator, but without lookout man approx. 1 sfr./square metre

Weeding machines for verges have not yet been tested on a large scale. Their use is only suitable if combined with other measures in the track area.

Manual weeding

There are several manual weeding methods. For example, the plants can be cut off or hoed out level to the ground with a sharp implement. Either all plants are torn out, or particularly undesirable species only (with the roots if possible). This produces more or less loose hollows in the verge which can further encourage seed germination. Some weeded areas are therefore treated with Glyphosate when the new plant cover has reached a height of 5 to 10 cm.

A weeding experiment on a limited area (eradication of common cranesbill in ballast) showed that the hourly performance per person was approximately 30 square metres. A thick growth of horsetail was removed from the ballast shoulder, and the performance was about 33 square meters. On larger areas however, it will not be possible to achieve this level of performance.

The effect of weeding will depend very much on the plant species, the thickness of the plant cover, the time of year, the local growth conditions, the weather and the seed reservoir in the soil.

Cost: 4 - 5 sfr./metre

Manual weeding is comparatively costly, but it allows a selective approach. Its effect varies quite much. Especially in the case of the horsetail, the effect does not last long.

Chemical Measures

Use of chemicals to remove individual plants from the track area is a delicate matter, considering their impact on nature and the environment. The operators must therefore be experts and act responsibly. For this reason, use of chemicals on SBB is governed by instructions «Chemische Vegetationskontrolle bei den SBB», in which detailed, binding rules are set out. One specific requirement limits the working with herbicides to staff in possession of a valid authorisation, or acting under the guidance of an authorised person. Apart from further restrictions, the use of herbicides outside the track area (ballast and verge), in the vicinity of rivers and lakes, and in ground water protection zones S1 and S2, is forbidden.

The restrictions and bans on herbicides, necessary to protect human health and the environment, are determined every year by the Federal Transport Office (BAV) in directives for all railways holding a federal licence (BAV, 2001).

Compared to the soil herbicide Atrazine that was in regular use on the railways up to 1989, the leaf herbicides containing the agents Glyphosate and Sulfosate, that are permitted today, bind better with the ballast and verge material where they degrade relatively quickly. Unlike with the soil herbicides, only small quantities of leaf herbicides are used now. These are absorbed by the plants through their green parts only and therefore cannot be used preventively.

In principle, the use of herbicides is banned in the banks alongside the tracks. An exception is the treatment of individual problem plants where these cannot be controlled by other measures, such as regular mowing.

Use of Glyphosate has been optimised for railway needs, including back-pack spraying devices and spraying trains.

Leaf herbicides like Glyphosate cannot be used preventively, but are applied directly to plants of existing vegetation. The effect of Glyphosate depends on the growth conditions, the presence of problem plants with underground propagation, the seed stored in the soil and the number of seeds brought in by the wind. This effectiveness can last for anything between 10 days and 2 years.

In conditions that are not favourable to growth, with treatment carried out at the right time and proper tending of the adjacent land, Glyphosate-based weed control can be successful over a longer period. It is recommended that the intervals between applications are varied (see SBB instructions «Chemische Vegetationskontrolle bei den SBB») to ensure that the vegetation does not have a chance to adapt to the changed conditions.

For further information, please refer to the SBB instructions «Chemische Vegetationskontrolle bei den SBB».

Areas in which the use of herbicides is prohibited

Track sections

- **ground water protection zones S1 and S2**
- **areas with protection status similar to ground water protection zones S1 and S2** (private drinking water sources, seepage and drainage installations)
- **in a buffer zone of 3 m alongside surface waters**
- **bridges**
- **track to be renewed before the end of June of the current year**

Other railway ground

- **trackside and roadside banks**
- **forecourts, parking and storage areas**
- **platforms**
- **loading platforms**
- **roadways and paths**
- **roofs**
- **terraces**
- **directly in and in a buffer zone of 3 m alongside hedges or small woodlands**

Back-pack spraying

Some 80 – 90% of all spraying on SBB is done using back-pack sprayers.

With a constant spray pressure of 2 bars and an average walking speed of approx. 1 m/s, about 50 litres of fluid will be needed per hectare.

Because of the fine spray mist, there is a considerable risk of the sprayed substance being blown away by the wind. Work should therefore be stopped during strong winds.

It is essential that the fluid be applied to the plants only, as otherwise the treatment will not be effective and can cause damage to adjacent property. The direction of the spray nozzle must therefore constantly be adjusted to the area being treated – standard practice for decades in viticulture and horticulture. It is also important that the spray always be directed towards the ballast bed from the exterior.

An SBB back-pack spray team will treat an average of 11 track kilometres per day.

Equipment investments (not including vehicle and training) amount to around 2000 sfr. per team.

Cost: 0.2 sfr./metre

Spraying train

Only a few motorised spraying units are still in use on SBB. These units are mounted on small wagons («Sputniks») and pushed by a light rail motor tractor. They are designed for an operational spraying speed of 15 km/h. A dosage device (Dosatron) provides a constant mixture of concentrate and spray water, which avoids leftover fluids and means that work can be stopped and started again at any time. The risk of water pollution from spillage is very low.

Cost: 0.25 sfr./metre

An operation that looks comparatively easy but makes heavy demands on the expertise of the staff. Correct and responsible spraying of leaf herbicides requires in-depth training.

Thermal Measures

Thermal methods of vegetation control such as infra-red (IR), burning, hot steaming and hot water treatment destroy plant cells through the effects of heat. Apart from the high energy consumption with the attendant financial and environmental consequences, also the generally short effect of these measures make them highly questionable.

Basically, only those parts of plants that lie above ground can be damaged by thermal measures. Their effect is therefore mostly short-lived and for plants that form runners or have strong roots, the impact is particularly slight, as was clearly shown in several trials.

Ecological audits have shown that to obtain with thermal measures the same degree of vegetation absence as with chemical measures, 5 to 14 times more energy is consumed (a satisfactory result from thermal measures requires several applications). This is also the main reason why this method has hardly been used in Switzerland to date.

Apart from the methods presented here, there are others which for railway application are as yet only in a trial stage (e.g. hot steaming).

Burning

Burning of plants with a propane burner similar to those used as point heater on SBB is admittedly effective at the beginning, but this tends to be short-lived since without a supply of heat to convert the liquid propane into gas, the pressure soon subsides.

The coverage achieved in an experiment reached 0.6 square metre/minute with propane consumption of around 222 g per square metre.

Infra-red devices

Combustible gases like propane are currently the cheapest source of energy for producing the type of infra-red that can be used to destroy plants. As the heated plates that radiate the infra-red rays need to be placed as close as possible to the surface, the area must be flat and free of obstacles for the mobile equipment to pass.

The models on the market include devices with a constant surface coverage (such as Thermflex) and others whose coverage diminishes after a short period of use depending on the temperature (such as Puzzy Boy).

The costs associated with thermal methods cannot currently be determined to any degree of accuracy. Once the ongoing SBB test with hot steaming is completed, the corresponding figures should become available.

Particularly young plants with as yet only a few leaves can relatively easily be eliminated with thermal methods and corresponding expense of energy, however the duration of effect is very short. And the real problem plants such as horsetail cannot be eliminated in this way.

Selection Criteria

The overview given on the following pages shows the benefits and drawbacks of different vegetation control measures in regular use on railway grounds today. When deciding on the best procedures, not only the technical pros and cons should be taken into consideration, but also the longer-term consequences in regard to costs and environmental impact.

Although the constructional measures have clear benefits, they can, for reasons of cost, normally be applied in tandem with scheduled renewal work only. This is why, in order not to discontinue railway operation, recourse must be taken to other measures that tend to attack the symptoms only. It is precisely with these methods that particular attention must be paid to environmental considerations. So whilst grasses and herbs can be successfully treated with the comparatively cheap herbicide Glyphosate, the same substance can under certain circumstances encourage the spread of horsetail.

Before deciding on one measure or another, the situation should be carefully considered and the impact of the various options analysed. What is supposed to be the direct path does not always produce the desired result.

Cost factor

From a financial point of view, it is the long-term cost-effectiveness of the various procedures that is of prime interest. Constructional measures for example are extremely expensive but also effective and have a long-time effect. In most cases, they also have other, positive side-effects at operational level.

For vegetation control, top priority goes to preventive measures. For this reason, the corresponding requirements need to be included into the planning and projecting phases of construction projects. Incorporating vegetation-specific concerns in the planning phases can bring substantial cost savings, and later save costs for direct action in vegetation control.

The same goes in many respects for the maintenance work needed for all types of railway installations. On a well-maintained line, the time and money needed to remove unwanted plants will be considerably less than on a line where upkeep is poor.

Environment factor

In vegetation control today, not only cheap, but also environment-friendly measures with a lasting effect are required. This is why priority is given to constructional and maintenance-related measures having a preventive effect. This does not mean, however, that the proper use of permitted leaf herbicides to eliminate existing vegetation is fundamentally less environmentally friendly than non-chemical procedures. Ecological audits have shown that many measures that may appear environmentally-friendly at first sight are in fact more damaging because of their high energy consumption, than the carefully targeted use of the leaf herbicide Glyphosate.

Methods attacking the symptoms are by no means a panacea that can meet all the financial, operational and environmental requirements imposed on vegetation control. Quite the contrary – with the increasing age of the railway installations, also the number of treatments needed each year to clear the track area of vegetation increases. This means that the most energy is expended on surfaces with the best growth conditions. The ratio between energy use (high environmental impact) and benefits obtained, constantly deteriorates. However, in the interests of railway operations, we have no option but to resort to these measures. At the same time, it might be worth considering where a certain amount of growth can be tolerated until the next renewal operation.

Comparison of Different Measures

	Procedure	Benefits	Drawbacks	Optimum range of use	Synergy effects
Constructional measures	**Bituminous weed barriers**	Optimal for keeping vegetation away from the ballast bed and the verge; stops underground incursions by problem plants	Line must be closed during installation	Best installed during construction or complete renewal	Protects substructure and the natural subsoil from water penetration, giving longer life as a result; cost-effective construction method
	Verge design	Ballast bed lastingly free of vegetation; reduces mower cuttings in the verge; herbicide use can be drastically reduced	Line possession or hindrance	Everywhere between the ballast bed and the bank	Protects substructure and the natural subsoil from water penetration, giving longer life as a result; cost-effective construction method
	Lateral barriers	Ballast bed lastingly free of vegetation; reduces mower cuttings in the verge; herbicide use can be drastically reduced	Line possession or hindrance	Everywhere between the ballast bed and the bank	Easier access to inspection walkways; lateral drainage of the ballast bed, depending on location and structure
	Porous concrete barriers	Ballast bed lastingly free of vegetation; reduces mower cuttings in the verge; herbicide use can be reduced; cheap!	Line possession or hindrance; possible clogging of drainage systems as lime is washed away	During the renovation of existing railway lines; dams where space is confined	Drainage, leading also to better trackbed stability, stable bank shoulders with little available space; inspection walkway
	Insertion of foils	Long-lasting barrier to plant growth; reduces mower cuttings in the verge; herbicide use can be drastically reduced	Line possession or hindrance; can hinder lateral drainage	In the verge (especially at the renewal of existing lines and in ground water protection zones)	Easier access to inspection walkways
Biological measures	**Greening**	Suppresses problem plants, prevents rapid spread of plants with runners; protects against erosion	Line possession required where access from outside not possible	After construction work, when plant cover in the transition band is patchy or absent; in bank areas prone to erosion and slippage	Protection of nature and countryside; well-maintained bank (image); protection against erosion
	Mowing	Suppresses problem plants, prevents bush growth and runner incursions; protects against erosion	Line possession required where access from outside not possible	In meadowland and poorly-stocked areas; in the transition band and adjacent bank	Protection of nature and countryside; well-tended bank (image); protection against erosion
	Selective embankment maintenance	Treatment suitable to local conditions; flexible application, not subject to weather conditions	Requires knowledge of existing vegetation	Wherever necessary, in the extensive maintenance area, in areas with bushes and hedges	Protection of nature and countryside (protection of rare plant species possible); stabilises the bank and improves operating safety
Mechanical measures	**Ballast cleaning**	Lasting effect against seed-dispersion weeds	Line possession required; cost-intensive	Necessary throughout to ensure longevity for tracks	Gives an opportunity to make minor adjustments of the track level; elastic positioning of rail surface
	Suction method	Slows the formation of humus; specially effective against seed-dispersion weeds	Line possession necessary; no depth action; cost-intensive	Removal of surface material (humus, cigarette ends, rubbish, leaves, etc.) especially in station areas and on lines through forests	Removal of dirt in station areas (image)
	Mechanical weeding	Longer absence of vegetation in the ballast; reduces mower cuttings on the verge; use of herbicide drastically reduced	Line possession necessary, cannot be applied everywhere; cost-intensive	In the presence of humus on compacted gravel verges (cuttings, slopes, ground water protection zones)	Easier to walk on inspection walkway
	Manual weeding	Flexible application, not dependent on weather conditions, energy-saving, low environmental impact	cost-intensive; often short-lived effect only	Selective removal of individual plants, clearing of small areas (e.g. in ground water protection zones)	Easier to walk on inspection walkway; removal of plants reduces humus formation
Chemical measures	**Back-pack spraying**	Cheap, line possession not necessary, energy saving, targeted application	Requires specialist knowledge; effect depends on location and weather; encourages growth of resistant horsetail	On ballast shoulder and verges; no preventive effect	None
	Spraying train	High surface area coverage	Line possession necessary, cost-intensive; dependent on weather conditions	Big trackyards with little traffic (e.g. shunting yards)	None
Thermal measures	**Burning**	Easy to implement	Poor propane consumption to effect ratio; destruction of plastic components; danger of fire; air pollution	Application not recommended	None
	Infrared devices	Small, lightweight equipment	Limited impact on luxuriant growth; danger of fire; risk for plastic components; air pollution	For minor growth (seedlings) on easily-accessible, level surfaces free of obstacles	None

Common Weeds in the Track Area

Most of the plants to be found in the track area propagate by seed dispersion. Many are perennials and difficult to control from the second year onward (e.g. creeping thistle). For this reason alone, measures that prevent plant growth (by taking away their supplies of water and nutrients, or by setting up competition with other, comparatively harmless species) should be given particular consideration. Furthermore, many problem plants grow on soil structures that are also bad for railway operation, and in areas where soil replacement would be recommended anyway. The following overview looks at five typical problem plants commonly found in the track area and outlines the best way to deal with them.

Horsetail

Equisetum arvense
Perennial, with much-branched, extensive root system reaching down to a depth of 1 or 2 metres. Propagates through rhizomes and sprouts. Penetrates the track area from below. Sandy or gravelly coverings and old ballast dumps encourage its growth.

Control: Complete removal can only be achieved by constructional remediation of ballast and verge. If this is not possible and the growth is problematic, horsetail growing in the ballast can be torn out by hand. This is expensive and must be repeated several times a year, as the roots generally remain in the ground and the plant regrows quickly.

Treatment with Glyphosate should be avoided by all means! It has no effect on horsetail and even encourages its growth by eliminating competing plant species. A thick growth of grass adjacent to the verge to compete with the horsetail will stop its spreading quite effectively.

Deep-seated drains and compact asphalt layers are the most effective measures against horsetail.

Cranesbill, Herb Robert

Geranium sp.
Annual or biennial, with a thin taproot, grows to a hight of 10 to 50 cm; has reddish flowers and produces seeds from April to October; propagation with large numbers of seeds. Spreads rapidly especially in the ballast of shunting and marshalling yards. Hardy, germinates in late summer where damp persists in fine-grained matter and impurities of ballast. It spends the winter there as a hardly perceptible seedling that grows up fast in the spring. Growth of cranesbill will increase the humus content of the ballast.

Control: Glyphosate treatment, after local inspection, must take place without fail before plant reaches seeding maturity in the spring (approx. late April). At this period, only areas where cranesbill predominates should be sprayed, as Glyphosate has as yet no effect on some other plants. In cases of thick growth, a second treatment is recommended before the next generation goes to seed.

Treatment after seeding maturity will actually encourage the spread of cranesbill!

Japanese Knotgrass

Reynoutria japonica
Perennial, thin-walled stems up to more than 3 metres tall and 4 cm across, vulnerable to frost. The rapid growth stops end of May. The root system, serves to store nutrients and from its buds, stems grow above the ground. It spreads out below the surrounding vegetation at a rate of up to 2 metres per year. Reproduction takes place mainly via the rhizomes, and also (though rarely) via the stems. In poorly maintained banks and also on gravel and old ballast areas, it will supersede the smaller, established vegetation and grow into the track area from below.

Control: Must be cut back to near ground level in early August. In September, when the stems are around 40 cm high, they are treated with Glyphosate, and the following year, when the new growth has reached about the same height, mow it or treat it again with Glyphosate. Further propagation can be prevented by regular mowing (five to six times a year) and adjusting the soil conditions (possibly in combination with lateral barriers).

To achieve sustainable elimination, specialist advice must be sought.

Reeds

Phragmites sp.
Grows up to 4 metres in height; perennial, with long underground suckers over a metre deep. Spreads through rhizomes and suckers, to a lesser extent by seeds. In soils with a poor load-bearing quality, damp and generally rich in nutrients, reeds will penetrate into the track area below ground from untended banks.

Control: Annual mowing of greened verges and adjacent transition bands in June/July (and again in mid-September if necessary). Subsequent growth in the verge should be treated with Glyphosate when knee-high from the end of August. Good drainage of the track area (possibly in combination with lateral barriers).

Mowing is necessary in June/July, as by this time, the larger part of the winter reserves has been taken up from the roots and is not available for lateral propagation.

Brambles

Rubus sp.
Perennial; runners up to 7 metres long grow out from the rootstock. From early August, their ends grow back into the ground and form new rootstocks. Propagation by runners growing into the soil, root pieces, also to some extent by seeds. Incursion into the track area by spreading from unmaintained banks above the surface.

Control: Annual mowing of greened verges and adjacent transition bands, in June/July (optimal time), and again if necessary in mid-September. Subsequent growth in the verge can be treated with Glyphosate from late August.

Mowing in June/July is necessary, as by this time, the larger part of the winter reserves has been taken up from the roots and the subsequent growth is much less strong. Glyphosate treatment alone will seldom be fully effective.

Possibilities and Limits of Vegetation Control

How long any of these measures will be effective depends very much on growth conditions and local climate. In some cases, the effect can be very short, and it is here that the water supply to the soil, and the weather, play a central role.

Without first making a site evaluation, it is virtually impossible to predict how long the measures of attacking the symptoms will last. At most, a certain timeframe can be estimated. Constructional measures to repress plant growth, adapted to local conditions, can prolong the effect of other methods.

In most cases, the best solution is a combination of various measures, as the use of a single method generally has a selective effect: one species is being repressed, while another is encouraged.

Long lasting vegetation control

In vegetation control, constructional growth-inhibiting measures are especially effective. In the longer term however, our climate will always tend to create new habitats for plant growth as a result of erosion, frost, accumulation of dust, plant material, seeds and nutrients, and in the ballast bed additionally with fine attrition particles.

Aside from problem plants growing into the area below ground, the soil, after a phase without plant growth, is first settled by unpretentious plants. These will consume the little amount of water available in the soil, so that at first, no other vegetation will be able to compete. With ongoing formation of humus, other more demanding species will establish themselves, provided there is sufficient supply of water and nutrients.

Today, there is no cost-effective and environmentally-friendly method of ensuring that an area remains free of vegetation in the long term, if conditions are favourable to plant growth. Properly executed constructional measures to repress plant growth, and adequate maintenance, however will prolong the period during which plant cover is at an acceptable level by several years.

Combined measures

Given that every measure has a more or less selective effect, the gaps that are left will soon be populated by other plant types if the growth conditions are right. The situation is different if several measures are combined. For instance, mechanically scraping away of a surface layer of humus in the verge will create favourable conditions for Glyphosate treatment in subsequent years, because newly germinating plants are deprived of nutrients. An even more lasting impact could of course be achieved by reconstructing a good verge, fitting an effective drainage system or even installing a covered porous concrete bar.

Glyphosate treatment of seed dispersing weeds in the verge is an ideal complement to mowing in the adjacent land to combat lateral incursions of plants such as brambles, traveller's joy and reeds. The two measures must however be properly staggered or co-ordinated to ensure their effect is properly felt.

It is precisely when combining different measures that a green areas map or cadaster will prove particularly useful.

The best approach is generally a combination of methods, to ensure that gaps left in the vegetation are not taken up by other unwanted plant species. The example in the picture shows that a one-sided treatment with herbicides extremely favours the propagation of horsetail!

Selective impact

Most vegetation control measures have a more or less selective effect. In other words, whilst a given method kills a given plant, other species have more room to spread. Armed with this knowledge, we have the possibility to take carefully targeted action to favour individual species and repress others.

Regular tending will always lead to a shift of the composition of the flora towards species that are not much or not at all harmed by the measures taken. By regular mowing, for instance, we promote grasses, while species that form runners, bushes and trees, are repressed. If we use thermal methods to combat vulnerable annual or perennial plants with no particular storage capacities, we thereby encourage plants with underground reproductive systems (dandelion) or problem plants with underground suckers such as horsetail.

If Glyphosate is used only once a year, new plants can grow on the treated area in the meantime, given favourable conditions. This new vegetation will compete with and/or hinder the growth of horsetail, which is resistant to Glyphosate. If Glyphosate is used several times per year, on the other hand, the growth of this seasonal rival vegetation is repressed and the way is clear for incursions by horsetail. To create competition for undesired weeds, a regularly mowed and maintained plant cover should be tolerated on older or dirtier verges.

This last example shows clearly that caution and circumspection are required in the choice of control measures, if we do not want to effect the opposite of what we originally intended.

Plants that are relatively harmless in railway operating terms can provide competition in the transition band against lateral weed incursions.

Green verges

Wherever plants can grow, and have been removed, new ones will soon replace them. However we have the possibility to change the frame conditions for them (e.g. the soil properties). As not all plants favour the same conditions, we can thus exert an influence on the range of species growing in an area. This is a way of ensuring that eventually, we will only have species that do not pose problems for railway operation and maintenance.

The extent of annual growth is dependent on local conditions, and on the water supply first and foremost. As long as the trackbed is clean from top to bottom, there is no risk of vegetation taking hold in the ballast. If there is proper lateral drainage of the ballast bed, then until the next remediation of the verge, it will suffice to simply maintain the green verge (regular mowing to prevent the spread of runner-forming weeds, or resistant seed plants).

A plant cover maintained in such a way consumes and evaporates also vast quantities of water and protects the soil from erosion at the same time. The fine roots also act as a filter preventing very fine particles of soil from entering the drainage system. What is vital, however, is that the verge really is maintained regularly and that the cuttings are not left to lie on the verge, so that no plants can grow into the ballast.

Older, naturally greened and well-maintained verges can make an excellent contribution to vegetation control, thanks to their manifold functions.

Benefitting from synergy effects

Vegetation control measures, if properly applied, can generate synergies benefitting other railway activities.

Porous concrete barriers, for instance, bring a whole string of advantages for railway operations:

- greater firmness for the subgrade;
- more durable construction;
- greater stability for embankment shoulders;
- improved safety for staff (good inspection walkways);
- ballast shoulder stays free of vegetation for a longer time;
- less mower cuttings on the verge;
- effective barrier against plants (if properly maintained);
- low maintenance costs;
- low use of herbicides.

The example of porous concrete barriers shows how vegetation control measures - above all those related to construction and maintenance - can also have a positive effect on operations. Conversely, measures designed to limit plant growth can often be easily and cheaply incorporated into construction projects that have their own operational necessity.

Monitoring results is important

Monitoring of results is of central importance and requires a wholistic consideration of local conditions by a specialist – someone who can examine the vegetation present in the individual parts of the track, and draw conclusions as to the maintenance carried out so far, and the local properties of the soil.

The image of the railway

Last but by no means least, it is worth considering the railways' image in the eyes of their customers. The attention given to the maintenance of the banks, respectively the state of the banks itself and their appearance, are things that passengers notice. This in turn influences their opinion of the railway - an opinion that should matter to us!

Well-maintained banks can have a positive influence on passengers' opinions on the railway.

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Glossary

Ballast/ballast bed	Small blocks of stone made from unweathered and extremely hard rock that is crushed and screened. Provides an elastic basis for the track panel and allows adjustments of the track level to be made during maintenance work.
Bank	Bank is the term used to describe the areas of greenery along tracks outside the track area.
Bituminous weed barrier	Weed barrier made of bitumen or related material as a sub ballast layer. Prime function is to seal off water.
Clay	Smallest grain fraction of minerals (grain size < 0.002 mm).
Drainage	System/installations to drain water from the bearing layers of the sub- and superstructure.
Embankment shoulder	Interface between verge and bank.
Environmental audit	Assessment of the environmental impacts and compatibility of a given product.
Environmental compatibility	Assessment of the environmental consequences of any action.
Extensive maintenance zone	Area more than 5 metres from the track centre, where maintenance measures are determined according to the type of vegetation present or desired (as well as according to safety considerations). Roughly equivalent to the bank.
Glyphosate	Systemic leaf herbicide with excellent effect against most plant species.
Gravel sand	Frost-proof, compressible mineral material consisting of fine grains of stone of varying sizes, evenly distributed. SBB uses grade 1, SBB or 125 gravel sand.
Green area map	Map or cadastre of the green areas on SBB property along the track, containing data on location, existing and preferred condition of vegetation, and applicable maintenance methods.
Groundwater protection zones	Areas where ground water is stored and/or drawn, protected by law.
Herbicide	Plant-killing substance.
Humus	Sum of all dead and mineralised organic matter in the soil.
Intensive maintenance zone	Area up to 5 metres from the track centre, where safety aspects prevail in the choice of maintenance methods. Comprises the track area (including verge) and a 1-2 metres wide transition band between verge and bank.
Leaf herbicide	Weed killer, absorbed mainly through the leaves, and designed to eliminate the plant.
Local conditions	All the environmental conditions characteristic of a plant growth site (weather, situation, soil, etc.).
Minerals	Compact or loose rock that forms the solid part of the soil (as opposed to humus).
Mulching	Use of mowing machines fitted with a device to spread cuttings thinly over the surface.
Plant families	Groups of plants indicative of specific site conditions.
Porous concrete bars	Solid verge construction of porous concrete to stabilise the inspection walkway and embankment shoulder whilst preventing plants from growing into the track area from the bank.
Preventive measures	Preventive action against undesired vegetation.
Regenerative elements	Parts of plants that in favourable conditions can grow up again into complete plants.
Rhizome	Perennial, constantly growing root system storing nutrients and producing buds that each year send new shoots above ground.
Silicate	Mineral from which mineral nutrients are washed out through weathering (e.g. mica, feldspar).

Glossary

Silt (coarse clay)	Second-smallest grain fraction of minerals (grain size 0.002 - 0.06 mm).
Soil herbicide	Weed-killer. The agents that are toxic for the plants are taken up via the soil through the roots.
Spray solution	Ready-to-use dilution of weed killer with water.
Stone chippings	Broken up mineral matter with a grain size range according to load requirements and condition of the subgrade.
Storage system	Plant parts like beets, tubers, bulbs, rhizomes and the cotyledons of seeds that are used for the temporary storage of nutrients such as carbohydrates, fats, proteins, etc.
Substructure	Bearing layers between the ballast bed and the surface of natural subsoil.
Sulphosate	Leaf herbicide with almost the same effect as Glyphosate.
Symptoms, treatment of	Removal of existing undesired vegetation.
Synergies	Reinforcement of the effect of a single measure through a joint effect of two or several vegetation control methods.
Transition band	Part of the bank adjacent to the verge in the intensive maintenance area.
Tuber	see storage systems
Vegetation type	Division of vegetation according to structural features and plant composition (woodland, meadow, etc.).
Vegetation control	Control of vegetation growing on or near the railway tracks using a combination of different methods.
Verge	Lateral stabilisation structure adjacent to the ballast bed. It serves the staff as inspection walkway. The minimum width of an accessible verge is generally between 0.6 and 0.9 metres. To ensure good drainage, it must be built using permeable, large-grained material (SBB regulations R 211.1).
Woodland	Woody vegetation, as opposed to grassland.

Basic and further education possibilities

Specialist licence for the use of plant treatment substances in the maintenance of railway tracks and grounds.
Regular courses given by the Swiss Training Centre for nature and the protection of the environment (SANU) in Biel Switzerland, commissioned by the Swiss Agency for the Environment, Forests and Landscape. The objective of the course is to issue the corresponding licence.

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